

# The Future of Data Center Infrastructure

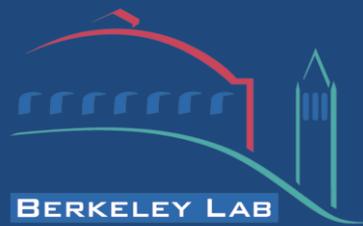


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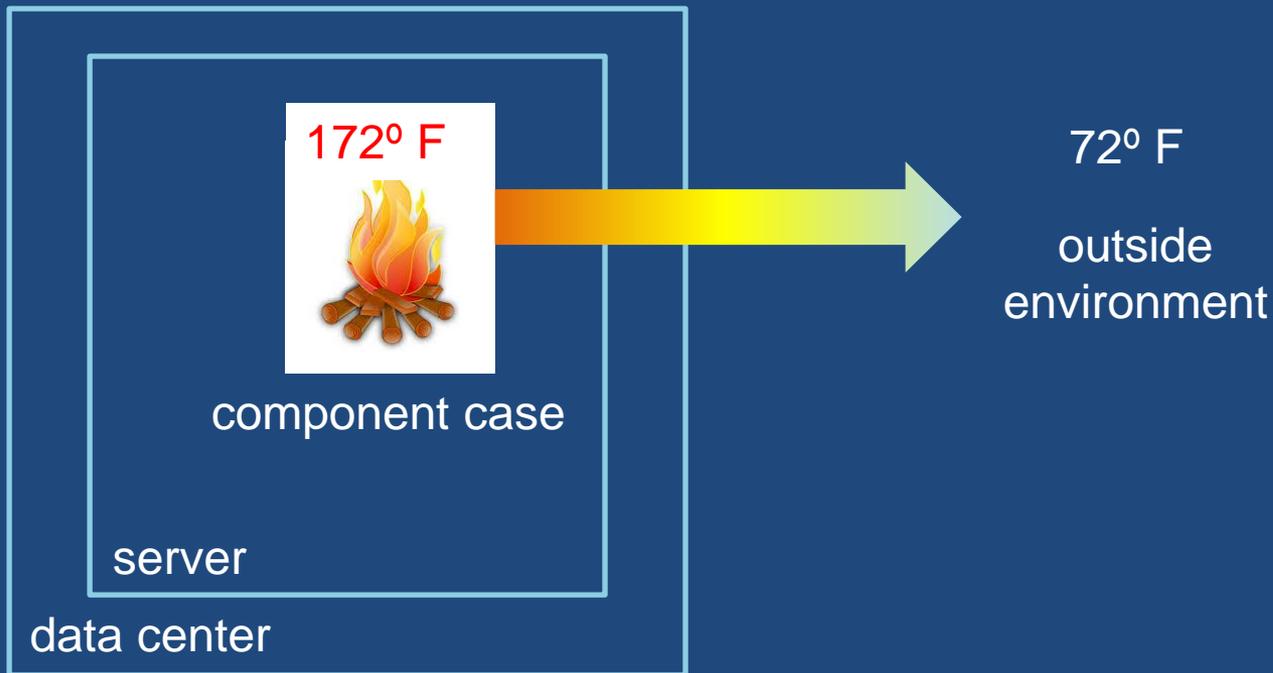
# Subjects

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- Cooling Infrastructure
- Electrical Power Infrastructure  
(Facebook Open Compute Project, DC power)
- IT Utilization  
(DCIM)
- Software Efficiency

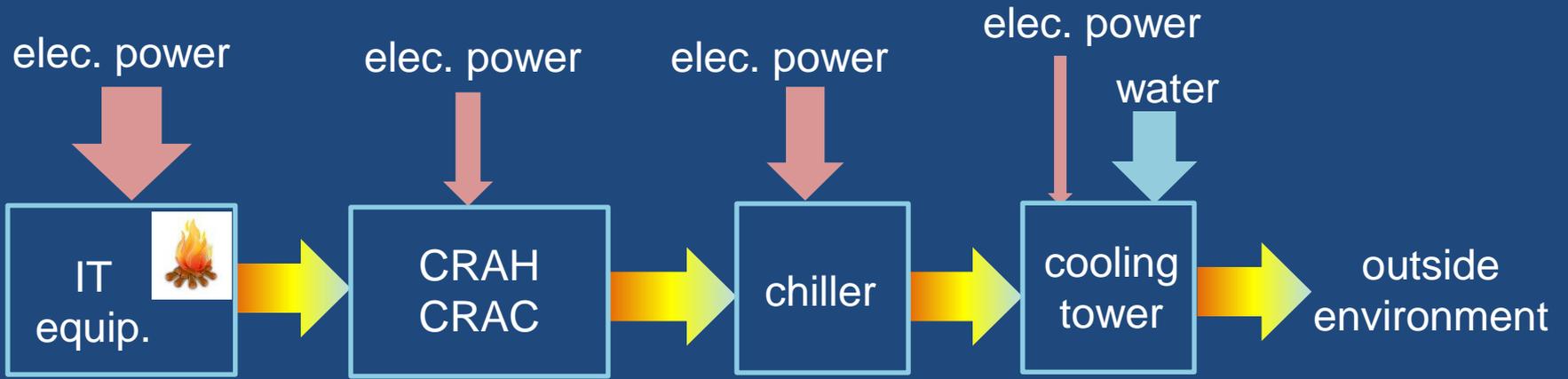
# Cooling

Cooling a data center is simple, just let the heat go outside.



# Conventional Technology

PUE: ~1.35-1.9+



What can we do?

# Newer Cooling Technology Examples

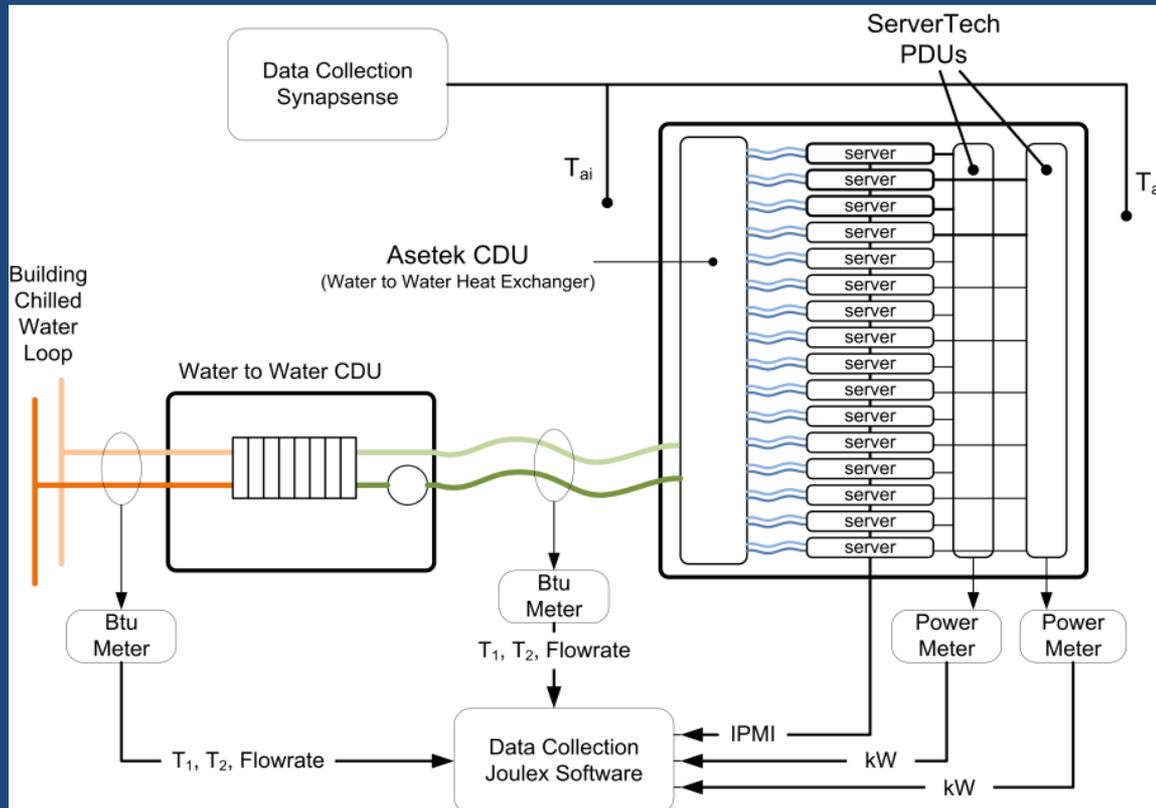
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- Direct Liquid
- Free Air
- Immersion
- Improved Conventional

# Direct Liquid

PUE: tbd

## Asetek RackCDU



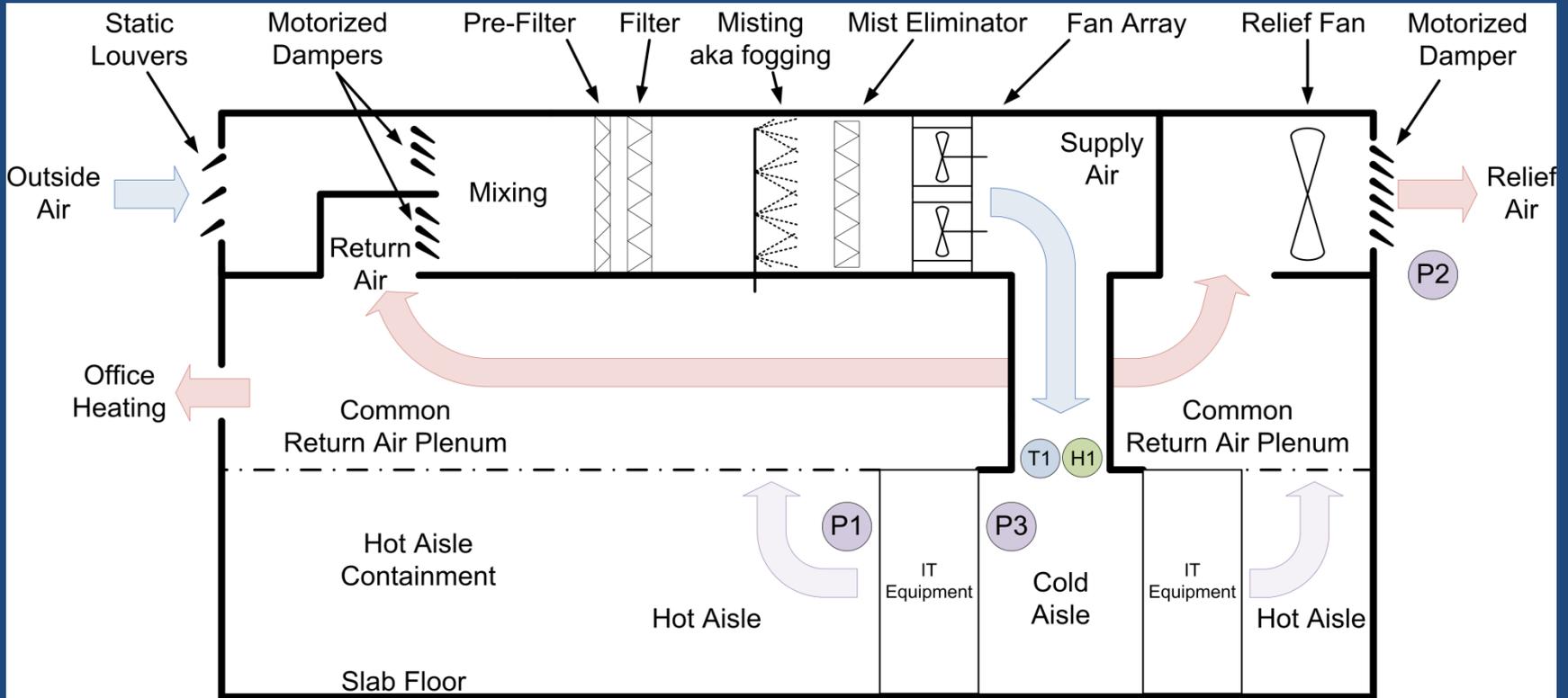
## Test Setup



# Free Air

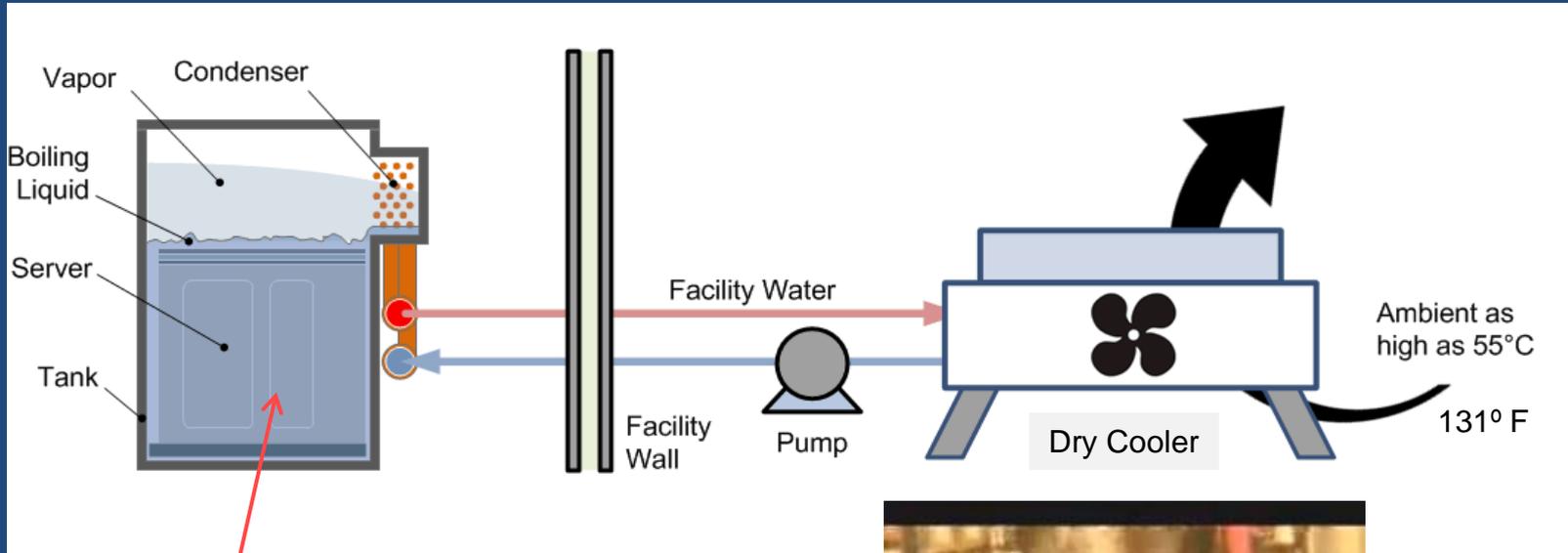
PUE: ~1.07

## Facebook Prineville



# Immersion

PUE: <1.1 ? tbd

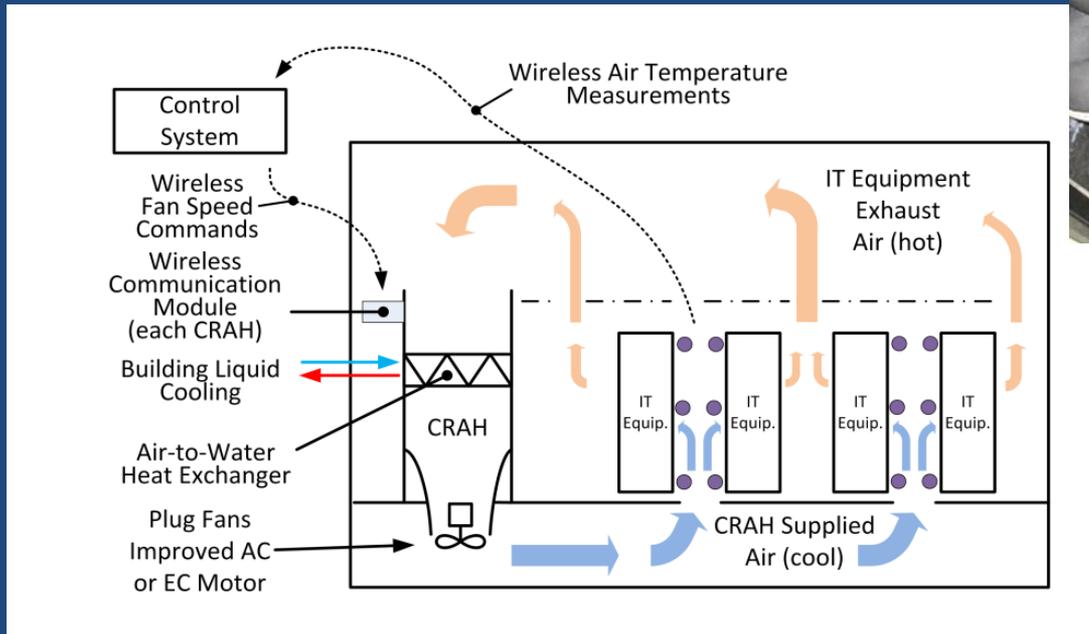


3M Novec 649 Fluid  
Boiling Point 49° C (120° F)



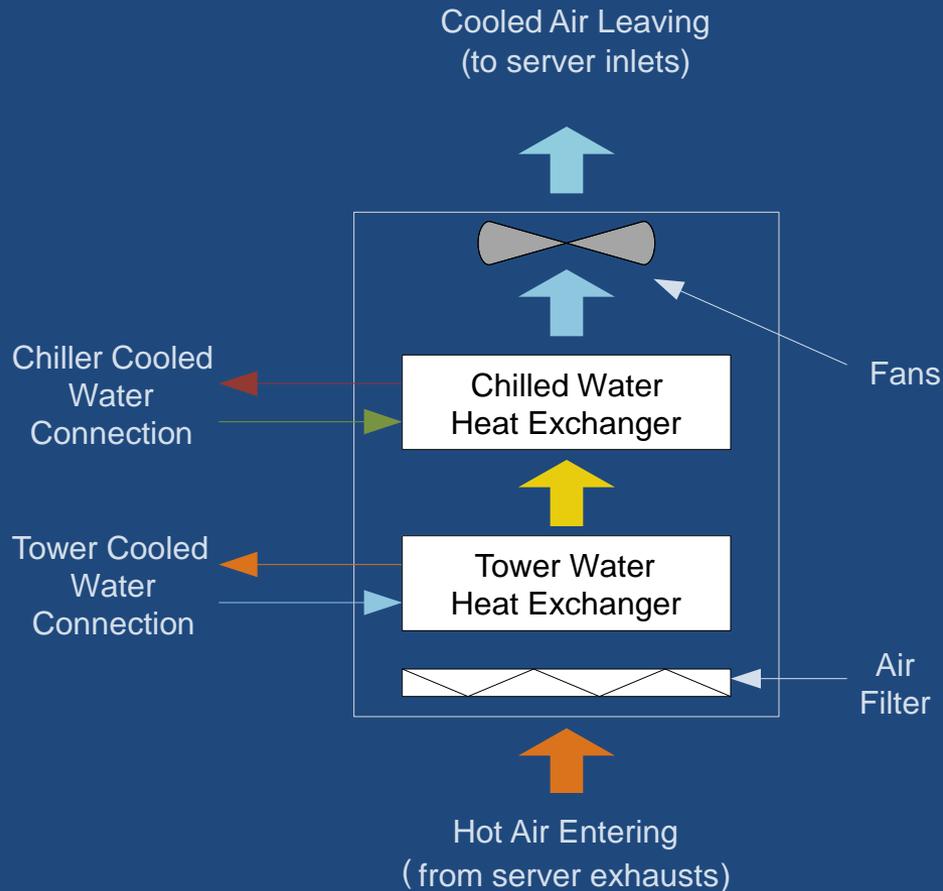
# Improved Conventional

Vigilant CRAH Fan Speed Control with Fan Upgrade  
CRAH Fan Power Consumption Reduced 66%  
Site Energy Reduction 8%



# Improved Conventional

Cooling COEE or Partial PUE (pPUE): 1.1-1.15



APC Dual Hex InRow™

# Improved Conventional

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What are these?



# Conclusions

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- Technologies to drastically reduce cooling infrastructure power consumption are now available.
- Alternate cooling technologies can provide significant reduction in water consumption.
- Cooling device innovation continues for conventional air cooled data centers
- Things are changing:
  - Allowable environmental limits are expanding
  - Heat transfer closer to heat source